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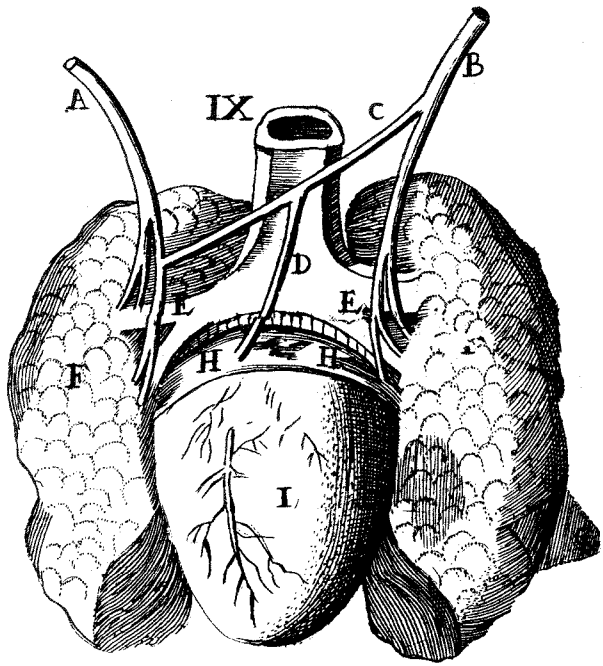

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About this issue. . .

This is a "body part" issue! One article lays to rest claims that human teeth have been found in Cretaceous deposits cut by the Paluxy Creek near Glen Rose Texas. Ronnie Hastings demonstrates in detail the results of his long-running monitoring of this (and other) Glen Rose claims. Once again, *C/E* reports on real research on claims too few scientists take seriously (claims which look silly nevertheless can attract a large following using the argument "No one from the Establishment has ever refuted this"). This case shows clearly how a "common-sense observation" can be dead wrong when viewed out of context—some fish incisors do indeed look like yours and mine, but when one asks further questions, as good scientists do, this similarity dissolves. Ronnie's patient investigation thus emerges as a model of how to apply skeptical analysis to claims—indeed, his investigation has already convinced some creationists. We present the details here, for the record, and hope (against all of the track record!) that no one again raises the hoary plaint, "They won't even look at the evidence! They won't let us get to first base!" Light on the evolution of the eye was to be shed by a brief article about current research but space problems have bumped it to a future issue, and Lorence Collins examines what the Bible says about other organs such as the heart and brain. Why is *Genesis* literally true and other passages metaphorical?

Back to whole critters, Daniel Blackburn answers the creationist challenge to "name just one transitional fossil," showing how this is a false argument—but also shedding light on transitional forms of birds, whales and other animals.

Also included is a review-essay by Stan Weinberg evaluating a new historical book on modern creationism; the article is also a documentation of Weinberg's pivotal role in the response by science and the public to the creationist challenge.

John Cole

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Volume 15 • No. 1 • Summer 1995

The journal of evolution and science education which explores aspects of evolution and antievolutionism

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A Tale of Two Teeth or, The Best of Teeth, the Worst of Teeth

Ronnie J. Hastings

On June 15, 1987, Carl Baugh, the leading proponent of widely debunked Texas "mantrack" claims, found a fossil tooth near some dinosaur tracks at his Paluxy River excavation site near Glen Rose, Texas, southwest of Fort Worth. He immediately proclaimed the tooth human and even named its former owner "Little David" (*Creation Evidences from the Paluxy* [CEP], 1987; Hastings 1987a, b; 1988), and some creationists continue to tout this "human" fossil today. It was found in the clay marl overlying the dinosaur track layer at what Baugh called the McFall Site II (CEP, 1987). Just as with the "mantrack" claims (many of which anteceded Baugh), this tooth was hailed as contributing to the death knell of evolutionary theory. It allegedly proved that dinosaurs and humans lived simultaneously in a world whose history is better explained by *Genesis* than modern science. Skeptics, however (including creationists who had been "burned" by Baugh's claims before), immediately suspected something was fishy about this new claim.

On June 19, 1987, the day the Supreme Court struck down the Louisiana Creation Law, I visited the excavation site. When Baugh himself arrived, however, he became angry at my presence but told me to expect a "surprise" he was about to announce to the press (Hastings, 1987a), although he did not tell me it was the tooth.

Early Announcements and Cautions

A week later, newspaper coverage trumpeted the find and noted the testimony of dentists confirming the tooth's human origin. It was supposedly from a juvenile male, although how its gender was ascertained was not explained. A trilobite was also said to be associated with the tooth. Newcom-

Dr. Ronnie Hastings is a Waxahachie, TX high school science teacher, former NCSE Board member, and long-time monitor of Glen Rose, TX creationist claims.

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ers to the controversy such as Don Patton hailed the claim, as did prominent creationists such as A.E. Wilder-Smith and Clifford Wilson (Somervell *Sun*, 1987).

In early July, Baugh and Patton took the tooth for identification (although they were already calling it the incisor of "Glen Rose Man," *Humanus Daviddii Glen Rose*—"Little David," with its own catalog ID, part of which was "FSCM," used hereafter). *[Ed: Note the claim by anti-evolutionists to have found a completely new Genus, species and subspecies of human!]* Paleontologist Arthur Busbey at Texas Christian University, Fort Worth, was consulted, and identified it as a fossil fish tooth similar to specimens he had on hand (DeVilbiss, 1988). Next, Baugh and Patton took their find to the Vertebrate Paleontology Laboratory, Balcones Research Center, University of Texas at Austin. Professor Ernest Lundelius and graduate students Melissa Winans, Kyle Davies, and Sally Shelton identified it as an incisiform tooth from an extinct primitive bony fish called a *pycnodont* (Carroll, 1988), perhaps ancestral to the gar or bowfin. However, Baugh and Patton apparently deny this identification ever took place (CEP, 1987).

Brought also to the Balcones lab was part of what the creationists had called during June television coverage an apparently associated "trilobite." This was but a row of pycnodont grinding or crushing teeth, specimens of which had already been found in lower Cretaceous deposits along the Paluxy (Thurmond, 1974). Such a row within a rock matrix can look a bit like the periphery of a trilobite to a naive observer. Apparently, Patton and DeVilbiss (1988) persuaded Baugh to back away from this trilobite identification after the Austin trip.

Figure 1. Fossilized FSCM incisiform, labial or lip side; scale in mm. (Drawn by Sean Cagle from a photo by Don Patten)

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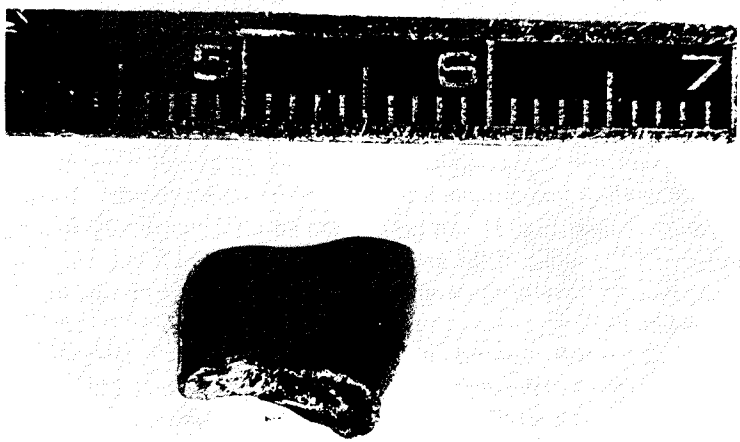

Figure 2. Fossilized IH2 incisiform, labial or lip side; scale in mm. (Photo by Stanley D. Parker)

Things Become More Fishy

The tooth FSCM was called a "milk" or deciduous tooth supposedly because only its crown was present. It was 7.9 mm in width, 5.8 mm in average height, convex on the outer or labial side, and concave on the inner or lingual side (CEP, 1987) [Fig. 1]. A wear facet on the upper lingual face (toward the medial or mesial side) was claimed as uniquely human (or, at least, mammalian), but such facets occur in any opposing sets of cutting teeth, mammalian, reptilian, or piscine. Its missing base or pedicle prevented immediate identification as piscine or mammalian using gross morphological structure (Peyer, 1968).

Never explained consistently were the separate claims that FSCM was "knocked out" and that it was deciduous. If FSCM was a tooth fractured at the base of the crown, how could it be claimed permanent or deciduous without microscopic observation? Even were it not fractured, a fossil tooth with only a crown does not mean it is deciduous, for roots of permanent teeth are very susceptible to erosion compared with crowns after burial (McLellan, 1988a, b).

July correspondence from Wann Langston Jr. (1987), also of the Balcones lab in Austin, indicated to me the pycnodont identification. Pycnodonts were primitive, bony-scaled fish that lived throughout the Mesozoic into the Tertiary. Complete North American skeletal remains are almost non-existent, but many complete skeletons from European Mesozoic deposits exist. Jack McLellan, an amateur paleoichthyologist, noted that many of the pycnodont incisiforms found in the Cretaceous of central Texas had features similar to FSCM (McLellan, 1987).

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Undaunted by their Texas university visits, Baugh and Patton took FSCM to the National Museum of Natural History in Washington D.C. in late July, learning that I was inquiring there about fossil fish teeth while on family vacation. There Raymond Rye and Robert Purdy told them the same thing they had told me—Langston had correctly suggested that many types of fish have human-like dentition, including the modern sheepshead or *Archosargus probatacephalus* [Fig. 3]. An early German reference Purdy found (Guttormsen, 1937) spoke of the great similarity of certain fossil fish teeth with human incisors, and the museum was easily able to show piscine fossils with incisor-like teeth.

Back in Texas Patton and I met in Dallas on August 11, 1987, confirming that we had received the same information from the National Museum. Patton evinced a strong belief that the lab in Austin and the museum in Washington D.C. had conspired to corroborate each other's analytical results, although they had not consulted with each other. According to Patton, the lab implied FSCM was human and that the museum had been misleading about its own fossils. Despite the lab's and the museum's independent emphases to Baugh and Patton that dentists were not usually authorities on comparative anatomy, Patton continued to show strong faith in dentists' identification of the tooth as human.

Patton kindly provided me additional photos of FSCM (publication of which was subsequently always denied me), confident in the humanity of FSCM. He seemed to me firmly unaware of Baugh's questionable reputation as an investigator with a bad string of claims (Cole and Godfrey, 1985; Godfrey and Cole, 1986; Hastings, 1986; 1988; Kuban, 1989; McIver, 1987; Schadewald, 1984a, b).

Three days later at the Austin lab I found that Baugh and Patton had misinterpreted scientists' remarks during their July visit. The many examples of fish, both modern and extinct, that possess "human-like" front rows of opposing incisiforms seemed to make no impression upon them; they interpreted "human-like" to mean literally "human!"

Baugh then published a series of black-and-white "Displays" as an addition to their previous newsletter (CEP, 1987). None of the information given them by the Austin lab and the National Museum indicating the tooth was probably piscine seemed to affect their still-strong conviction that FSCM was human. The "Displays," in fact, attempted to discredit the fish I.D.

Some Fossil Fish Teeth of My Own

In correspondence, Paluxy field colleagues Glen Kuban and John Armstrong questioned just how rare were fossil fish teeth like FSCM along the Paluxy. Beginning in mid-October at the Kerr Site, just across the river from the FSCM find, I found, with the assistance of Rick Neeley, several isolated small grinding teeth and tooth fragments imbedded in limestone cobbles as

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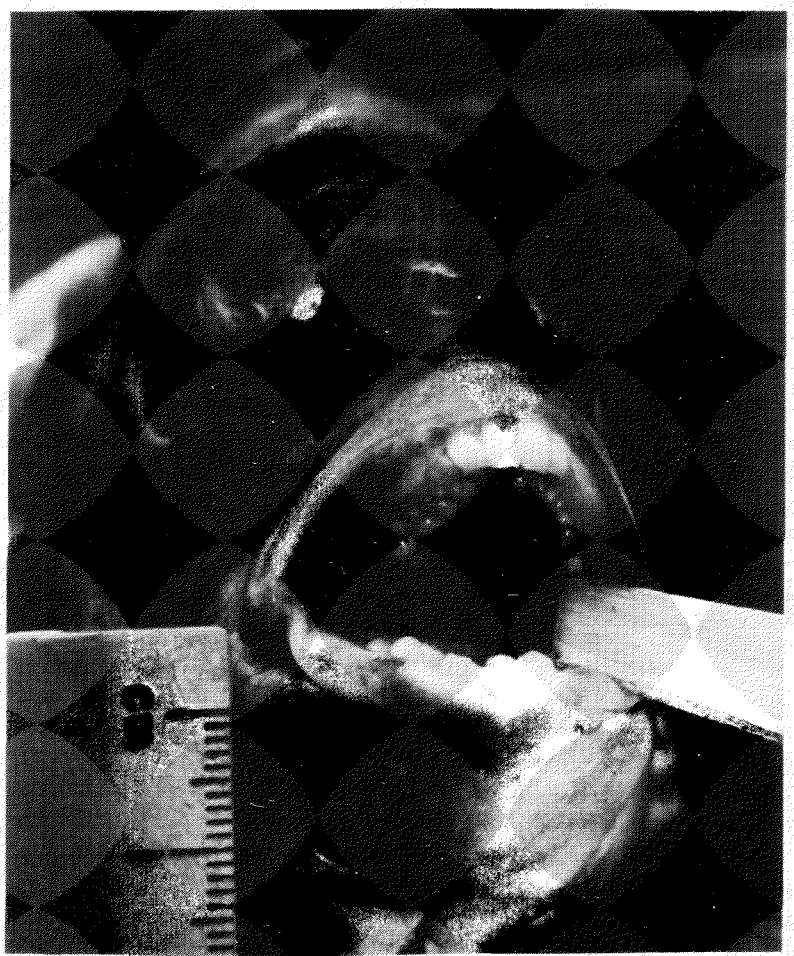

Figure 3. Modern sheepshead fish head showing opposing rows of incisiforms. (Photo © by Glen J. Kuban)

well as a few fossilized pycnodont scales. Among my October finds was only one incisiform tooth (IH1), which was sheared lengthwise after fossilization, leaving a height of 6 mm and a width of 5 mm. It was only similar to, not exactly like FSCM, having a pulp cavity definitely characteristic of fish teeth (Peyer, 1968).

The presence of fish teeth in and near saurian track layers is consistent with what we know of that lower Cretaceous broad tidal flat environment (Langston and Pittman, 1987). Marine fish would have fed, probably at high tide, on hard shelled prey, losing teeth in the process.

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Enter IH2

On Halloween, 1987, at site TSA, some few kilometers downstream from the FSCM site, I found FSCM's close facsimile, assisted by Rick Neeley and Jay Woods. A bit larger than FSCM, it was 1 cm in length, with a sloping height varying from 4 to 6 mm [Fig. 2]. FSCM has a vertical fracture line on its labial side, whereas IH2 is smooth [Figs. 1 and 2]. FSCM is apparently an upper right or lower left incisiform while IH2 probably is an upper left or lower right. FSCM has a smoothly worn wear facet, and IH2 wear pattern looks like a pock mark on its inner side.

Their similarities overwhelm their differences. The two teeth are not only similar in overall dimensions, they have the same fracture pattern at the base. Both are amber to dark brown in color and translucent to strong light. Their pulp cavities have similar shapes, and the degree of concavity appears near the same. There is no compelling disparity between the two to justify considering them to be from different kinds of organisms. A year later I would find several more similar fish teeth in the area.

Micrographs

As long as Baugh and Patton continued to insist upon the humanity of FSCM despite evidence to the contrary, further analysis was now warranted upon both teeth. Microscopic analysis using a scanning electron microscope (SEM) can clearly distinguish between human and fish teeth even if only the crowns are left. Most fish teeth are made of dentin, while human or mammalian teeth are of enamel, each type a certain arrangement of orthophosphate hydroxyapatite (McLellan, 1988b). A photographic result of a SEM scan, or micrograph, will reveal a different pattern for teeth from different animals; there is also a small range of variation in human teeth micrographs, depending on the particular area scanned, the nature of the agent used to etch the tooth surface in preparation for scanning, and the condition and kind (deciduous or adult) of tooth (ten Cate, 1985). Fossil teeth result from partial or complete geochemical replacement of the original tooth material, but the microstructure of the dentin or enamel is faithfully retained (Bunney, 1985). Hence, a fossil tooth or a modern tooth of the same type of organism should scan similarly and show similar micrograph patterns.

Before IH2 was found, Baugh had FSCM scanned by David Menton of the Department of Anatomy, School of Medicine, Washington University, St. Louis, MO. In Menton's words, SEM observations on FSCM "seem to exclude the possibility that FSCM is human." No characteristic enamel "prism" patterns of human dentition were found on both FSCM areas scanned (Menton, 1987). Its pattern, however, matched well that of a scanned sheepshead fish tooth, leading Menton to suggest FSCM was a tooth from a pycnodont-like fish similar to sargodon (Guttormsen, 1937).

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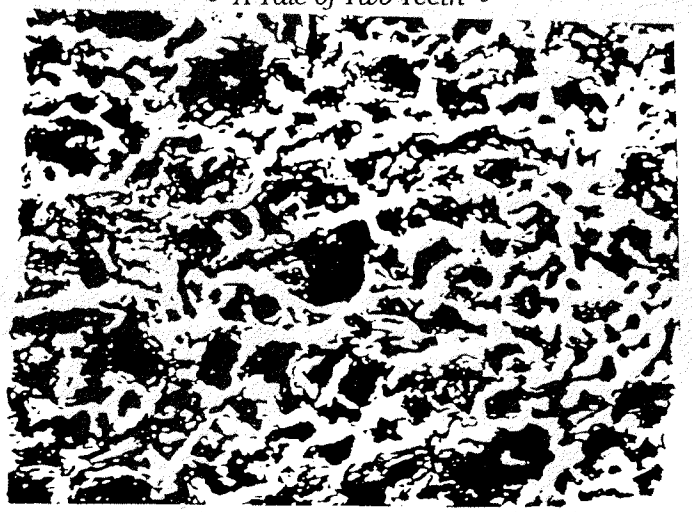

Figure 4. SEM scan of incisiform FSCM near its incisal surface, 1250X magnification. (Drawn by R. Hastings from photo of a micrograph by David N. Menton.)

Menton's analysis is particularly significant in that he is a young-earth creationist, an ICR board member, and a leading creationist in Missouri. In his report (p. 4) Menton shows human deciduous teeth are rarely found as fossils, and that if FSCM was indeed a fish tooth, then similar specimens would be found. Since this was before IH2 turned up, Menton was prophetic.

Despite Menton's micrographs, Baugh and Patton attempted to salvage the human identification of FSCM, citing that FSCM's micrographs looked similar to an aberrant human pattern within the spectrum of human dentition scans. According to Ranse Traxler, Missouri Committee of Correspondence liaison, Menton "was not pleased" that his analysis did not alter Baugh's and Patton's position. Patton (personal communication) claimed Menton later shifted from being so definite to only "highly probable" that FSCM was not human.

Photos of Menton's micrographs of FSCM did not show any obvious similarity to the aberrant human pattern; FSCM's scan showed a somewhat fibrous, robust, intertwined branching pattern [Fig. 4], while the aberrant human pattern (ten Cate, p. 214) showed clear remnants of badly eroded enamel prism boundaries.

Baugh and Patton seemed to be arguing that macroscopic features of incisors or incisiforms have little variation, while microscopic features have greater variation. But this is to argue counter to general patterns found in the anatomy of teeth of all types. Variation in macroscopic features is normally more pronounced (Wheeler, 1974) than that of microscopic features such as human incisor SEM scans (ten Cate, 1985). That macroscopic anatomical features of human and fish dentition can display a great deal of similarity is

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not surprising, whereas the different molecular structures of the two types of teeth would predict very different SEM micrographs taken at analogous sites on the two types.

Clearly I had to have IH2 scanned. Kuban and I planned a series of scans which could be used for direct comparison. With the help of Wann Langston, Jr. I arranged for scans at the Austin lab. I sent IH2, a large pycnodont grinding tooth, and a modern human incisor donated by Stanley Parker, D.D.S. Kuban submitted two modern fish incisiforms from a Florida sheepshead (*Archosargus probatacephalus*) and a modern woodchuck tooth.

The December 1987 Seminar

In late December my son Dan and I attended the Creation-Excavation Seminar held at Glen Rose. Not a lot of seminar time was spent talking about FSCM, perhaps because upon my arrival Baugh and Patton had approached me about the "new tooth" they had heard I had. After explaining that it was still at the lab for scanning, I showed them my photos and casts. Patton more than Baugh commented on similarities. Very little was said about differences. I urged Patton to inform the seminar about Menton's SEM results on FSCM, which was never done. Later, I learned that Baugh and Patton planned to argue that IH2 was a fish tooth, but that FSCM was still human. Their noose was tightening.

On the afternoon of the first day's excavation I gave one of my many sets of photos of IH2 to Paul Goaz, Professor at Baylor College of Dentistry in Dallas. Goaz was very surprised to see opposing incisiforms with cervical features on the crown bases in the head of modern sheepshead which Kuban had shipped to me just before the seminar (the same fish head from which Kuban had pulled two incisiforms to be scanned at the lab in Austin). Goaz found the wear facets and cervical features of the IH2 casts and photos equally surprising, as he had thought all these features exclusive to mammalian teeth. Goaz' whole perspective on FSCM seemed to shift, thanks to IH2 photos and a smelly fish head from Florida [Fig. 3], and in the following month a letter from him confirmed this.

The 1988 Interim

It was not until April 1988 that a report on Menton's analysis of FSCM appeared in the creationist press (*Bible-Science Newsletter*, 1988). The results of the analysis came across only with careful reading. Though knowing of IH2 through the December seminar, IH2 was not mentioned, as if FSCM was still an isolated find: "Menton has commented that if the tooth is indeed the tooth of a pycnodont, it is likely that additional examples will be found at the Paluxy. This will greatly aid in testing, and increase the

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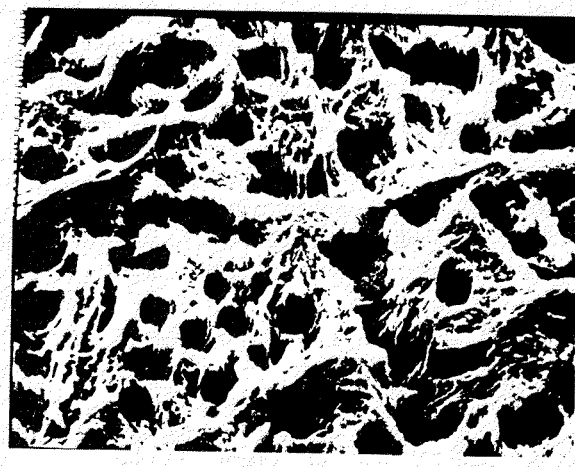

Figure 5. SEM scan of incisiform IH2 near its wear surface; 1200X magnification. (Micrograph by Rick Toomey)

likelihood that the tooth belonged to the pycnodont. On the other hand, if the tooth is human, it may be unlikely that another sample will be found."

In late July, 1988, the results of a conclusive "new analysis" on FSCM finally came and were announced by Patton at the monthly MIOS meeting. They were anything but conclusive. According to Patton FSCM was sent to the Immunology Department, California State University at San Francisco, for a collagen protein test in which scrapings from FSCM's pulp cavity were analyzed for fossil protein. Though any results were apparently compromised by moisture contamination, this did not deter Patton from declaring the test showed no indication for fish and too little for human protein. I declared my immediate interest in having IH2 similarly tested, but Patton said relations with the California lab had been severed, and that it was expensive anyway.

By late August my collection of fossil fish teeth consisted of 5 pycnodont-like incisiforms, 163 pycnodont-like grinding teeth or tooth fragments, 75 fossilized fish scales, and 6 spike or reptile-like teeth. I had also seen a fossilized pycnodont jaw with rows of grinders but no incisiforms found by someone else. This tally did not include the many fossilized fish teeth and fragments found by creationists at the FSCM site and acknowledged as piscine.

An example of such a creationist tooth finder was Art Chadwick, a creationist instructor at Southwestern Adventist College, Keene, Texas, near Glen Rose. Chadwick's fossilized fish tooth collection apparently resembled mine, complete with an incisiform resembling FSCM and IH2 found near the FSCM site (Chadwick, 1988). Over the phone Chadwick made it clear that

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as much as he would like to, he could not see any likelihood that any of his finds could be human.

Long-Awaited Results

By September Patton was speaking to me again. In fact, he seemed in a hurry to scan both FSCM again along with my IH2. He wanted me to get IH2 back, almost as if he was curious to see whether I had such a tooth, so long was the delay at the Austin lab. I asked for but was refused permission to publish photos of FSCM.

It wasn't until early December, 1988, that my tooth set was finally returned from the Austin lab scanned. Equipment breakdowns and subsequent back-logs accounted for the delay. Performed by Rick Toomey of the lab, the scans produced micrographs which corroborated both Menton's FSCM results and macroscopic comparisons of FSCM and IH2.

IH2 and the sheepshead tooth scanned virtually the same, showing the fibrous, branching, non-uniform pattern typical of fish dentition [Fig. 5]. And this pattern matched that of FSCM [Compare Figs. 4 and 5]. On the other hand, the modern human incisor showed the expected mosaic of enamel prism patterns [Fig. 6] with similar mosaics appearing in scans of the woodchuck tooth Kuban had sent and of a raccoon incisor the lab had contributed. My offer to Menton to share copies of these results was never answered or acknowledged.

When he learned that I had IH2 back in my possession along with micrographs of the tooth set, Patton ceased to be so anxious to re-scan FSCM and IH2. At the January, 1989, MIOS meeting I was finally introduced to Dr. James McIntosh of the Baylor College of Dentistry in Dallas, who Patton had said would do scanning for us. McIntosh was very quiet as I showed him my collection of teeth and micrographs. He agreed that the whole set could be re-scanned for further corroboration.

Surprise Announcement

Although I had thought Patton and I had agreed to scan our specimens together, I learned before the February MIOS meeting that FSCM had already been re-scanned. I made an appointment with McIntosh to have at least IH2 re-scanned. During the February meeting Patton's talk was curious. His subject was that similarity does not always mean genetic relationship—a major point *against* FSCM being human. This was but to soften the blow for the major presentation—both Baugh and Patton took the stage to announce that they now thought FSCM was *not* human, but was from some kind of fish!

Apparently their last hopes were dashed by McIntosh's analysis of FSCM. Convinced that Menton's scans of FSCM did not go sufficiently below the

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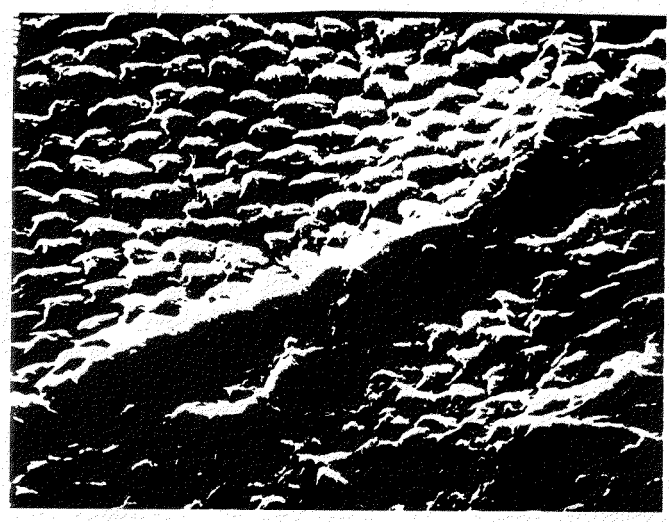

Figure 6. SEM scan of a modern human incisor enamel on the crown near its wear surface; 1300X magnification. (Micrograph by Rick Toomey)

surface, he sectioned FSCM vertically for an internal scan. Only a low-magnification micrograph of the cross section was shown to the audience, showing the crown much too thick to be deciduous. The internal scan reportedly gave a clear piscine pattern with no semblance of human enamel prisms, though we were not shown it [Fig. 4]. It was all over; not even Baugh or Patton could avoid throwing in the towel.

Smoke Screens and Whistling in the Dark

The rest of the evening was spent by Baugh, Patton, and the MIOS President in damage control. They emphasized that here is proof that creationists can indeed come to scientific conclusions following the evidence. To the extent that they allowed the evidence in the end to paint them into a corner, they did behave scientifically, and for this Baugh and Patton should be commended.

But why did it take so long for them to come to the same conclusions as their scientific critics from the very beginning? Patton very candidly admitted they were motivated throughout to embarrass scientists whom he and Baugh believed "lied" to them. They emphasized how scientific they had remained throughout the almost year and a half since FSCM had been discovered, always maintaining tentative conclusions until "all the evidence was in." But there is nothing tentative in such published statements as "and our tooth remains uniquely identical exclusively to the human tooth" and "Our fossil remains uniquely human" (CEP, 1987). No more tentative are ". . . suspended 5.8 inches in the clay was a human tooth!" and "The Creation

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Evidences Museum of Glen Rose, Texas has announced the discovery of a 7.9 mm wide human incisor tooth thirty inches from a dinosaur print" (Baugh, 1987, pp. 144, 147, respectively). Clearly FSCM's finders were convinced from the outset that FSCM was human.

Finishing Detail

As the expert testimony of dentists helped fuel misidentification of FSCM, so also did it help finally close the case on FSCM. McIntosh scanned IH2 at Baylor College of Dentistry for me as planned in March, 1989, scratching well below its surface for an internal scan. As with FSCM, he found no evidence of the prism patterns associated with human teeth in IH2. Its re-scan showed the piscine pattern once more, though McIntosh said he thought the pattern was a different fish pattern than FSCM's fish pattern [Compare Figs. 4 and 5]. If they are different, the two teeth perhaps came from two different kinds of Cretaceous fish sporting incisiforms.

Summary and Closing

The irony of this "tooth tale" is that the creationists involved have committed the same error they and other creationists have inaccurately attributed to evolutionary scientists—creating an entire human fossil from a single tooth! A few scientists in the 1920's much too hastily described a pig's molar as belonging to an ancient North American "Nebraska Man" (Wolf and Mellett, 1985; Gould, 1989). Oddly, during his damage control on the evening of February 28, 1989, Baugh conjured up the deadly comparison, quoting the myth that "Nebraska Man was used as evidence at the Scopes trial!" (Perhaps it might have been, but Judge Raulston did not even allow experts to testify about evidence.) And Patton argued the same misinformation months later. It seems to me the actions of Baugh and Patton have effectively removed from the creationists' arsenal a useful story, apocryphal though it was.

Of course had Baugh and Patton pursued corroborative evidence as good science demands, they would have found piscine fossils as I did. After they showed little or no inclination to search for more finds, I seized the opportunity to find additional evidence. This pursuit not only led to finding IH2, but also corroborated the initial assessment by Langston and other scientists at his lab, by Art Busbey, and by the National Museum in the summer of 1987 right after FSCM was found. By the end of summer, 1987, for most scientists the matter would have been settled. By the end of 1987 for even a lot of creationists the matter would have been settled. But not for mantrack and "mantooth" enthusiasts; the matter had to be played out to the bitter end, consuming energy, money and time.

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Although as late as 1994-1995 Baugh sometimes recycles long-defunct tooth tales, they are belied by the events of 1987-1989, when it became clear that a fish tooth by any other name remains the same. To use a friend's phrase, in the end Baugh and Patton got "the tooth, the whole tooth, and nothing but the tooth."

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Does the Bible Contradict Accepted Biological Concepts?

Lorence G. Collins

Creation scientists insist that the Bible is infallible and that it must be interpreted literally in regards to applications in science. For example, Whitcomb (1973, p. 95) says:

> For a Christian, the written Word of God, correctly interpreted, must be the starting point for arriving at valid conclusions in every significant realm of meaning. If the God-honored and time-honored method of grammatical-historical ("normal") interpretation of the Bible is valid, then Biblical statements of history and doctrine cannot be twisted at the whim of the interpreter.

But a literal interpretation of the Bible in the realm of science is based on the assumption that the writers of the scriptures wrote precisely like "Greeks," when in fact much of the Bible was written by Hebrews, who wrote poetically. The point of this article is that when scriptures are taken literally and they produce nonsense, then science should be given preference. Examples of biblical quotes to demonstrate this point are taken from the King James version because this interpretation is commonly used by many creation scientists. Entirely different nuances of meaning can be obtained from other translations, but basically the same point can be made. By choosing only the King James version, I have attempted to follow the aforesaid restrictions imposed by the creation scientists. For example, if a creation scientist selectively chooses only what he or she wants to hear from each of many different translations, then such selectivity violates the dictum that "doctrine cannot be twisted at the whim of the interpreter."

On that basis, the following is written to test the restrictions, imposed by creation scientists, as to how the Bible ought to be used. Illustrations are

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presented from three areas in modern biology: (1) the function of the heart versus the brain, (2) the male and female roles in procreation, and (3) the manner in which wheat kernels germinate.

The Heart versus the Brain

In *Strong's Exhaustive Concordance of the Bible*, which is a listing of primary words contained in the King James version of the Bible, the brain is not mentioned once, whereas the heart is cited 826 times. Thought and emotions, however, can be said to occur in one's head or mind, and, therefore, the citations of "head" (360 times) and "mind" (96 times) must be examined. An analysis shows that although the head contains the brain, in the Bible the word "head" is used only in two senses: (1) as a reference to that part of the body that can be, for example, bowed, injured, or crowned, or (2) to represent leadership when someone is described as being the "head" of a household, church, or a government. But the "head" is not represented as the site where all thinking and emotional feelings originate.

This analysis also applies to the word "mind," although in a few places "mind" is simultaneously used in the same sentence with the word "heart." In these places, however, it still is not clear from the context that the mind is located in the brain or head. For example:

> . . . which is in mine heart, and in my mind . . . *I Sam* 2:35
> . . . perfect heart and with a willing . . . *Chr* 28:9
> . . . with all thy heart, with all thy soul, with all thy strength, and with all thy mind . . . *Luke* 10:27

These examples, however, could just as well represent the writers' use of different words to mean the same thing in order to give emphasis, which is a literary technique commonly used in the Bible.

In the Bible the heart is considered the seat of life or strength. Hence, it means mind, soul, spirit, or one's entire emotional nature and understanding. The heart also is the primary source of such bad behavior as adultery, hatred, lust, mischief, pride, and rebellion as well as such neutral or good behavior as desire, doubt, fear, gladness, love, obedience, and sorrow. The heart is the organ that is said to have the ability to reason, question, meditate, motivate, and think. All of these mental processes in today's world are normally associated with one's mind or brain and not the heart (except metaphorically).

God or the Lord is described as being able to know, search, enlighten, open, recreate, examine, strengthen, and establish one's heart—not the mind. One can have a clean, contrite, perfect, pure, or wise heart, but those qualities are not biblically attributed to the mind.

The following are biblical examples from the King James Bible of emotional states or mental abilities of the heart[1]:

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. . . he will be glad in his heart . . . *Ex* 4:14
. . . he will harden his heart . . . *Ex* 4:20
. . . hate thy brother in thine heart . . . *Lev* 19:17
. . . For as he thinketh in his heart, so is . . . *Prov* 23:7
. . . But what comes out of the mouth proceeds from the heart, and this defiles a man. For out of the heart comes evil thoughts, murder, adultery, fornication, theft, false witness . . . *Mt* 15:17-20

Today we may ask, "How did I get this thought in my mind?" Not once does the Bible attribute having thought(s), thinking, understanding, considering, meditating, or pondering as coming from the mind.

These mental processes generally are cited as coming from the heart. For example[2]:

. . . consider in thine heart, that the . . . *Deut* 4:39
. . . understand with their heart, and convert . . . *Is* 6:10
. . . thine heart shall meditate terror . . . *Is* 33:18
. . . and pondered them in her heart . . . *Luke* 2:19
. . . perceiving the thoughts of their hearts . . . *Luke* 9:47

One example exists of thoughts coming into a person's mind: " . . . thy thoughts came into thy mind . . . " *Dan* 2:29. But this "thoughts-mind" association is immediately followed in the next passage by an explanation of where the mind is " . . . that thou mightest know the thoughts of thy heart . . . " *Dan* 2:30.

Reasoning (questioning), which is a mental process that is generally associated with the brain or mind, is also clearly defined as coming from the heart. For example:

. . . and reasoning of their hearts . . . *Mark* 2:6
. . . Why reason these things in your heart . . . *Mark* 2:8
. . . What reason ye in your hearts . . . *Luke* 5:22.

Being wise, having wisdom, knowing, or having knowledge or learning are also normally considered as mental processes occurring in the mind or brain, but these qualities are associated in the Bible only with the heart. For example[3]:

. . . He is wise in heart, and mighty in . . . *Job* 9:4
. . . ye know in all your hearts and in all . . . *Josh* 23:14
. . . and apply thine heart unto my knowledge . . . *Prov* 22:17
. . . I applied my heart to know wisdom . . . *Eccl* 8:16

The process of learning and acquiring knowledge and wisdom, therefore, in the Bible is an application primarily of the heart rather than the mind.

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In one place in the Bible the word "mind" is associated with the word "wisdom," " . . . and here is the mind which has wisdom . . . " *Rev* 17:9. But here again, there is no clue that the writer knows where the mind is. The other dominant citations certainly imply that the mind is considered to be in the heart.

Because of the biblical influence on language, the word "heart" has continued in modern usages to parallel biblical patterns. For example, we speak of a "broken heart" in a jilted love relationship, and we have bumper stickers today that say "I ♥ my dog," or "I ♥ Jesus." We do not interpret the latter to say "I muscle Jesus," even though we know that the feeling of love cannot reside in cardiac muscle tissue. Moreover, we do not translate the heart symbol into any feeling other than love, even though the Bible says that hate or lust also originates in the heart.

As another example of biblical influence on language, a young man may woo a girl by saying: "I love you with all my heart." Likely, she would not react as favorably if he told her: "I love you with all of my brains."

The lack of a modern scientific interpretation of the function of the heart in the Bible occurs because in the time of Jesus, the people considered the heart as the center of the body. All arteries lead from the heart. It pulses with life. The brain was thought to be some kind of organ that filtered the blood, but otherwise it was relatively unimportant.

The custom of offering blood and sacrifices to gods was common in many ancient cultures and supports the contention that ancient cultures considered the heart to be more important than the brain. The Israelites also continued this custom when they offered blood from animals that were sacrificed to Jahweh in their Temple in Jerusalem. In none of these ancient cultures was the brain sacrificed.

This misunderstanding of the importance of the brain is also illustrated by the Egyptian culture. When their temple priests mummified their pharaohs, they carefully cut out the heart and saved it for the preserved body, but they scraped the brains out of the skull through the nostrils and threw away the scrapings.

On the basis of the above analyses, if the Bible were an accurate guide today to medical science, then, emotional feelings, knowledge, and wisdom should be considered to reside in the heart and not the brain. Therefore, in our medical institutions, if creation scientists are correct about the scientific accuracy of the Bible, we should be teaching today's psychiatrists and medical doctors to treat the heart with drugs for mental diseases, to operate on the heart for mental problems, and to ignore the brain in these situations.

Male and Female Procreation

When ancient farmers planted a grain of wheat, it grew to produce a wheat plant, which in turn produced more wheat seed. From this observation, it was only logical for these Old Testament people to conclude that sperm or semen

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that come from the male are like kernels of seed, which a male inserts into the womb of a female. In this case, the female is a vessel to hold the seed. On that basis, the female in ancient cultures was important only to carry and nurture the prospective offspring; e.g., *Gen* 16 and *Gen* 19:32-36.

The semen or sperm that came from the male was imagined to be a fully-formed human being, only miniature in size. The male just planted these tiny humans into the female. Therefore, it was a sin for a male to spill his seed or semen on the ground, because he was killing little human beings (*Gen* 38:8-10).

With the understanding that the male is the source of life, and not the female, it was extremely important for the male to have a son to pass on his life to the next generation. If the female did not bear any children or only female babies, then there was something wrong with her, but never anything wrong with the husband. Therefore, the cultural pressure on her was enormous to have a son. If she did not, she would beg her husband to find a concubine to bear him a son (*Gen* 16).

We now know, of course, from modern science that it is the union of an egg from the female and the sperm from the male that produces a child, and neither parent is more important for reproduction than the other. But in the male-dominated society and culture of the Old Testament and during the time of Jesus, the Old and New Testament writers would not have known this.

Growth of a Wheat Seed

Concerning the growth of a wheat seed, we read in the Bible a parable by Jesus, who says, " . . . Truly, truly I say to you, unless a grain of wheat falls into the earth and dies, it remains alone; but if it dies, it bears much fruit" (*John* 12:24).

The Greek word used in this passage to indicate to "die," is used in all other places in the Bible to mean physical death. Therefore, no other translation of this word is likely. On that basis, if the Bible is supposed to be an accurate science book, this passage produces an error. A dead seed does not germinate and grow. You can treat the passage metaphorically and obtain a moral lesson, but you cannot say that the Bible truly represents modern science.

The Creation Science Response

How does a creation scientist handle these three scientific problems in the Bible? I corresponded with one to find out. (This person is identified by using "he" or "his," but the reader can also assume a female.) He has written many articles on science and the Bible and will not be identified in this article to preserve anonymity. I assume, however, that his replies are typical.

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Heart versus the Brain Response

My correspondent chose to avoid my suggestion that the omission of the word "brain" in the Bible implies that the brain had little importance to biblical writers and/or that its function was poorly understood. Instead, his reply concentrated on three relationships: (1) the significance of the word "head," (2) whether "thought" is said to come from the "heart," and (3) whether "mind" and "heart" have equivalent usages in the Bible. I have paraphrased his responses.

1. Significance of "Head"

My informant chose not to use the King James version of the Bible but cited the New American Standard Bible as having significant statements.

. . . wise man's eyes are in his head . . . *Eccl* 2:14
. . . Christ is the head of every man . . . *II Cor* 11:3
. . . Him as head over all things . . . *Eph* 1:22
. . . Christ also is the head of the church . . . *Eph* 5:23

And then he pointed out that it is obvious that wisdom dwells in the head and not the heart and that Christ is the head and not the heart of man.

In spite of these reasonable biblical quotes and points, it is not obvious from the first quotation (Eccl 2:14) that the source of wisdom is in the head. The eyes of a wise man are obviously in the head and not the stomach or the leg, for example, but are eyes to be equated with wisdom? The source of wisdom of the wise man could just as well be in the heart or anywhere in the body. This scriptural passage does not elucidate where wisdom originates.

In the other three biblical quotations concerning Christ as the head of every man, head over all things, and head of the church, "head" is used to represent a leadership role and has nothing to do with wisdom or thought. All four quotations in no way suggest that thinking, thought, or reasoning originate in the head.

2. Thought from the Heart?

The response continues by pointing out that in *II Cor* 10:5, "bringing into captivity every thought to the obedience of Christ" certainly does not mean "heart." But how does he know? Who can tell from this biblical quote where "thought" comes from?

3. Equivalent Usages of Heart and Mind in the Bible

In regard to the equivalency of the words "mind" and "heart," his response provided the following quotations from the New American Standard Bible, which is then followed by the creation scientist's arguments.

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. . . in his right mind . . . *Mark* 5:15-20
. . . changed their minds . . . *Acts* 28:6
. . . over to a depraved mind . . . *Rom* 1:28
. . . complete in the same mind . . . *I Cor* 1:10
. . . being of the same mind . . . *Phil* 2:2

He avers that here the word "mind" cannot be replaced with "heart" and make any sense out of them. He opines that although heart and mind are comparable in many places, they are certainly not equal and do not refer to the same entity.

In the aforesaid arguments he dodges the issue. The word "heart" could very well be substituted in each of these quotations on the basis of the many examples given in the first part of this article in which emotional expressions and mental thoughts are attributed to the heart.

If it is true that the Bible is scientifically accurate in separating the mind from the heart as being distinctly different, then somewhere that distinction might be expected to be clearly "spelled out." For example, let's look again at three examples of the aforesaid quotations to emphasize points previously made.

. . . he will be glad in heart . . . *Ex* 4:14
. . . why do thoughts arise in your heart . . . *Luke* 24:38
. . . nor understand with their heart . . . *John* 12:40

In all usages recorded in Strong's Concordance of the words that apply to emotions or mental capacities, which for some words is several hundred citations, there are no equivalent passages that read, for example:

. . . he will be glad in his mind (head) . . .
. . . why do thoughts arise in your mind (head) . . .
. . . nor understand with your mind (head) . . .

And this lack of equivalency applies to all other quotations listed in the first part of this article as well. The few exceptions are those aforesaid quotations in which emphasis is likely being used or in which "mind" is explained to be equivalent to "heart."

A passage that the creation scientist did not include in his response is, " . . . a wise man's heart discerneth . . . " *Eccl* 8:5. This passage seems to be a direct indication that wisdom comes from the heart. Moreover, the following passage was also omitted in the response: ". . . The words of a wise man's mouth are . . . " *Eccl* 12:11. It might be equally logical, therefore, to argue that "it is obvious" that the source of wisdom lies in the mouth.

In all arguments made by the creation scientist for the three items which were discussed above, he uses modern-day knowledge that the mind is in the

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brain, when, in fact, if he were true to a literal reading of the Bible, he would have to argue that this knowledge is false. For example: " . . . why do thoughts arise in your heart . . . " (*Luke* 24:38).

Response to the Question of Human Procreation

I did not pose this question to the creation scientist because it was my experience from a year's correspondence on geology and other science topics that this question was unanswerable from a creation science point of view. Like our modern knowledge of chemistry, the biology of sex is not discussed in the Bible, and, therefore, the Bible has no opinion on this subject from which the creation scientist could argue or defend.

Response on the Question of a Dead Seed

The creation scientist responded to my question on the ability for a dead seed to germinate in two separate letters. In the first response he indicated that although such germination cannot naturally occur to produce a plant, creation scientists believe in the supernatural. God can make a lifeless seed grow. He posited that although miracles are rare, a plant does not need a soul in order to be resurrected. His final points were that Jesus in this biblical passage was merely using a parable to demonstrate the need for self-sacrifice, and that there is no need for naturalism to explain a miracle.

Three contradictory points were made here by the creation scientist. The first is the agreement that modern science is correct in showing that dead seeds cannot germinate. The second is that a miracle can explain the process in the time of Jesus. The third is that the biblical passage should not be interpreted scientifically, but metaphorically in which a parable is used to illustrate the need for self-sacrifice. He says that miracles are rare, but the quotation implies that every wheat seed that was planted in Jesus' time went through this miraculous resurrection. That number is a lot of miracles. A supernatural explanation is certainly an easy way to get out of the difficulty of explaining what happened, but such an explanation is not science.

After having more time to think about this issue, the creation scientist wrote again and re-emphasized his feelings that this passage should not be taken literally but be interpreted as a parable. He felt that the people whom Jesus addressed would have understood its proper interpretation for the need for his followers to make self-sacrifices. Then, the suggestion was made that my interpretation implied that Jesus used a wrong analogy for self-sacrifice, thereby I could be behaving improperly as a Christian. To hammer home his arguments further, the point was made that the Bible contains a great deal of literature, including similes, metaphors, hyperboles, analogues, personifications, and many other forms of speech, which should not be taken literally. The obvious example was then presented, using the paraphrased statement

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from Jesus: "This is my body. Take and eat," when it is understood that the bread of communion "represents" his body.

Thus, the creation scientist in the second response admits that the Bible cannot be taken literally, and by doing so, he admits that in this example, the Bible is not scientifically accurate. He escapes the problem by insisting that the Bible must, in this case, be interpreted metaphorically. This example presents a problem, however, because creation scientists must now choose which places in the Bible are to be treated literally and as true science and which places are to be treated as moral lessons without scientific accuracy.

Conclusion

The Bible contradicts three modern basic biological concepts. (1) The heart is not the source of emotions or the seat of learning, reasoning, and thinking; the brain is. (2) The male does not carry complete miniature human beings in the sperm, as the scriptures imply but do not specifically say. And (3) wheat kernels cannot germinate if they "die."

Efforts by "creation scientists" to explain these concepts and to make the Bible a perfect science textbook simply fail because the creation scientists rely on modern science to support their arguments rather than on evidence in the Bible. They conveniently avoid using literal translations, where necessary, in order to make the Bible fit our present scientific understandings. The absence of scientific accuracy in some places in the Bible should not be surprising because it was never written by trained scientists to produce a science textbook. Even if it were written by scientists, because science is constantly producing new knowledge, it would be impossible for biblical science-writers to anticipate all the changes that new discoveries require.

Notes

[1] Additional examples are: *Jer* 13:10, *Acts* 28:27, *Is* 10:7, and *Mt* 9:4.

[2] Other examples are *Deut* 15:9, *Dan* 10:22, *Job* 38:35, *Ps* 19:14, *Prov* 8:5, *Prov* 31:12, *Mark* 7:21, *John* 12:40, and *Luke* 24:38.

[3] Other examples include: *Ex* 35:26, *Jer* 24:7, *Ps* 90:12, *Prov* 16:23, *Eccl* 2:3, and *Eccl* 7:25.

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Paleontology Meets the Creationist Challenge

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Paleontology offers one of many bodies of evidence for the evolution of life. However, unlike technical information from molecular genetics, cladistics, and embryology, the significance of fossils is clear to a public that is acquainted with dinosaurs and other extinct forms through books, movies, and museums. Consequently, the fossil record is a major focus of the creationist attack on science. Numerous creationist books promote claims that the earth is only a few thousand years old; that rock strata indicate nothing about geological history; that fossils are remains of animals that died in a great Biblical flood; and that humans and dinosaurs coexisted in recent times. With the upsurge of creationist political activity, and the ongoing introduction of creationism into science curricula, teachers and scientists must be prepared to counter such claims with factual evidence.

Fundamental to the creationist position is the proposition that the fossil record fails to document origins of the major lineages of organisms. This claim is based on purported structural and temporal gaps in the fossil record between major taxa, gaps considered to represent acts of special creation by a divine entity (Gish, 1979; Bliss, et al., 1990). From such discontinuities, many of which are real, even creationists who acknowledge that species evolve from other species deny the possibility of macroevolutionary change (Moore and Slusher, 1974; Thurman, 1978). Oft-cited examples of gaps in the fossil record include those represented as the origins of whales, birds, hominids, flowering plants, and the invertebrate phyla. In a widely-distributed book devoted to fossils, Duane Gish (1979, p. 49) offered the following challenge to biology:

> "whether evolution actually did happen or not can only be decided, scientifically, established by the discovery of the fossilized remains of

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representative samples of those intermediate types which have been postulated on the basis of the indirect evidence. . . . *As a matter of fact, the discovery of five or six of the transitional forms scattered through time would be sufficient to document evolution.*" (emphasis added)

This paper responds to the creationist challenge by considering the significance of gaps in the fossil record; by demonstrating creationist confusion over the nature of transitional forms; and by documenting specific examples of how fossil evidence has documented the origins of major groups of organisms.

What Do Gaps in the Fossil Record Represent?

Creationist writings notwithstanding, discontinuities in the fossil record offer no real challenge to the phenomenon of evolution. Such gaps actually reflect the nature of fossilization, as well as aspects of evolutionary change.

To fossilize, an organism typically must contain hard parts that withstand action of microbes, predators, and the environment. Moreover, it must be deposited in a substrate suitable for fossilization, such as by being buried quickly in mud or sand (Raup and Stanley, 1979). After tens or hundreds of millions of years, the fossil then must be exposed at precisely the right place and time, if it is to be discovered by a human who has been trained to remove the specimen appropriately and document its discovery. Even a few weeks of wind or water erosion can destroy a specimen as a recognizable fossil. The 160 years during which our species has been seeking fossils for serious study represents less than *1 three millionth of 1%* of the time since the first vertebrates swam the oceans. We can only speculate what a minuscule percentage of the original fossil-bearing rocks from any particular time period are, at this geological moment, accessible for observation—for such rocks cannot lie buried beneath miles of earth or ocean, and must not have disappeared over the millennia through metamorphosis, subduction, or erosion. Obviously, the chances of any given specimen having been found as a fossil are infinitesimally small. Therefore, it is to be expected that many species will not be represented among fossils that thus far have been discovered.

Voluminous evidence indicates that species commonly arise as small populations that have become isolated from the parent stock—seeds of a plant that have been carried by ocean currents to a distant island, for example, or pocket mice isolated by a river. Such conditions are ideal for rapid change. Not only is the founder population unlikely to be fully representative of the parental gene pool, but random mutations are more likely to overtake a population if it is small. The more rapid the evolutionary change, and the more restricted the geographical area where it has occurred, the less likely that intermediates will be represented as fossils (Stanley, 1981). In addition, small genetic changes can have large phenotypic effects, and as a consequence, directional evolutionary change need not traverse phenotypic intermediates postulated by gradualistic scenarios (Gould, 1980). Thus, lacunae

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between species actually may indicate the mechanism of evolutionary change, rather than being an artifact of the record of fossil or living forms (Eldredge, 1985; Futuyma, 1981).

A further point about discontinuities in the species record is that the number of potential gaps *increases* with the number of known intervening forms. Gish (1979, p. 78) takes advantage of this point in discussing the Paleozoic fish-amphibian transition. While conceding that ichthyostegids appear intermediate between crossopterygian fishes and later amphibians, he argues that a gap now exists between ichthyostegids and fishes. The fact is, however, that until every possible intermediate is discovered, the more we know about the evolution of a lineage, the more hypothetical "gaps" it will contain. By definition, so-called "missing links" are, after all, missing. Therefore, the more successful a search for transitional forms is, the more self-perpetuating that activity is likely to be.

Characteristics of Evolutionary Intermediates

Anti-evolutionary writings exhibit considerable confusion over the features to be expected of so-called evolutionary intermediates. Such writings commonly assume that intermediate species must appear equally transitional in *all* of their phenotypic features. Thus, creationists reject the proto-avian *Archaeopteryx* as a link between birds and dinosaurian ancestors because it had fully developed feathers (Morris, 1974a; Gish, 1979). The presence of such "reptilian" features as forelimb claws and an unkeeled sternum in *Archaeopteryx* are discounted by creationists because they occur in a few living birds; that such features could have re-appeared in some avian lineages during the past 70 million years is ignored (Bliss et al., 1990). The "reptilian" feature of teeth in *Archaeopteryx* also is dismissed by creationists, for the puzzling reason that teeth were retained in other birds of the Mesozoic (Gish, 1979). To be considered as phylogenetically intermediate by creationists, a proto-bird must have partial, not complete feathers (see Bliss et al., 1990), not to mention partial wings and partial teeth (Morris, 1974b, p. 91). Whether such a form would also have to lay partial eggs and hatch out partial chicks has not been stated.

The well-known concept of mosaic evolution provides a useful framework in which to consider evolutionary transformations. Within a group of related organisms, morphological features can be considered as relatively ancestral or derived. Because features undergo evolutionary transformation at different rates and times, they can originate sequentially rather than simultaneously. As a result, any given intermediate species should be a mosaic or combination of ancestral and derived features. For example, as discussed below, *Archaeopteryx* is a mosaic of avian features as well as ancestral (dinosaurian) features, just as one would predict for a transitional form.

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Creationist publications also indicate confusion about how the stratigraphic record is to be interpreted. The creationist approach is to reject a fossil form as ancestral to a second when the two have not been found in successive rock strata (Bliss et al., 1990). However, this approach is based on the misconception that species transform progressively from one to another in a single unbroken lineage. When species arise through splitting of a filial population from a parental stock, ancestral and descendant species will exist at the same time; indeed, the former may well outlive the latter geologically. Add to these facts the spotty nature of the fossil record, and little reason exists to suppose that an ancestral species will necessarily have been found in older strata than its derivatives. Although fossil age and stratigraphic position are broadly suggestive, biology has abandoned them as precise indicators of phylogenetic relationships (e.g. Gaffney et al., 1995; Gauthier et al., 1988), in favor of cladistic analyses and molecular approaches.

More Anti-Evolutionary Confusion

Misconceptions in anti-evolutionary writings frequently stem from a reliance on incomplete or obsolete information. For example, Michael Denton's (1986) book offers several examples of purported gaps in the fossil record to demonstrate the implausibility of macroevolution. He illustrates the gaps by using arrows to link line drawings of skeletons of specialized descendants and putative ancestors, commonly on the basis of outmoded information. Thus, *Archaeopteryx* is linked to the primitive thecodont *Euparkeria*, in ignorance of the powerful evidence for the dinosaurian origin of birds. Likewise, the aquatic, Mesozoic plesiosaur *Cryptocleidus* (misspelled by Denton) is coupled to a terrestrial diapsid that predated it by 75 million years; evidence allying plesiosaurs with aquatic nothosaurs (Carroll, 1988) is not considered. Denton (1986) also links the skeleton of an Eocene bat with that of a modern shrew; with the latter drawn at twice the size of the former, the transition implied by the arrow between them appears implausible—as well it should.

Another problem with the creationist approach is that purported gaps are often an artifact of its own non-technical terminology. In well-documented evolutionary transformations between two major taxa, whether biologists label a species as belonging to one group or the other can be unimportant as well as arbitrary. A good example is offered by the transition between therapsids (formerly termed "mammal-like reptiles") and mammals. This transition has been documented in such detail (Hopson, 1987) that the demarcation of "mammals" from their ancestors is arbitrary and, by consensus, is based on features of the jaw joint and middle ear. Yet, Gish (1979) argues that therapsids are not like mammals, because they lack the mammalian jaw joint!

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Similarly, in the hominid fossil record, species of *Australopithecus* are dismissed as aberrant "apes," and *Homo erectus* is recognized as a "human," although a degenerate one (Gish, 1979; Morris, 1974a). Thus, as noted by Halstead (1984), semantic trickery is used to enlarge a discontinuity. To illustrate further, *Archaeopteryx* could be considered a bird or a coelurosaurian dinosaur; in fact, by a cladistic classification, birds *are* a dinosaurian subgroup. By defining *Archaeopteryx* as a bird by virtue of its feathers (Gish, 1979), creationists create a gap that they exploit to discount evolution. Yet, if birds were defined by the presence of an enlarged sternum (a specialization for flight, and arguably as good a criterion as any), the supposed gap might lie between the "reptilian" *Archaeopteryx* and its avian descendants.

The creationist preoccupation with "missing links" is retrogressive, and caricatures how paleontology actually proceeds. Indeed, the idea of intermediate forms is reminiscent of the pre-Darwinian "scale of nature," in which organisms were arranged along a continuum between protozoans and humans. Given that evolution typically involves successive branching, and that the fossil record will always be incomplete, discovery of a single common ancestor to each lineage is neither practical nor necessary. Of greater value to evolutionary biology is having enough species (extinct and extant) to detail the pattern of historical change. Thus, as Wheeler (1993) noted, a form can be considered as "intermediate" when it combines features of two distinct taxonomic groups, regardless of whether that form represents a direct link between them.

Most vertebrate systematists now analyze taxa through cladistics, a method that permits detailed reconstruction of the patterns of evolution, and that offers objective judgements of the features at each successive branch point. Cladistics contrasts markedly with the creationist approach, which is to try to imagine what transitional forms should be like, and then to chide paleontology for not having found them (see Kitcher, 1982, p. 111).

In view of the creationist challenge to biology, to identify even five or six transitional forms, it is enlightening to consider a few of the evolutionary intermediates that paleontology has found and analyzed.

Whale Origins

On the basis of details of skeletal anatomy, biologists consider whales to have originated from extinct hoofed mammals (ungulates) known as mesonychians (Carroll, 1988). Close molecular similarities between whales and living ungulates (e.g. Gemmell and Westerman, 1994), as well as cladistic analyses (Thewissen, 1994), provide independent confirmation of this interpretation. Although modern whales lack hind limbs, the limb elements develop in embryos and can be expressed as vestiges in adults (Conrad, 1983; Fezer, 1993). However, until recently, fossils documenting the transition

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from the mesonychians to ancient whales (archaeocetes) have been scarce. As a consequence, creationists have held up for special ridicule the idea that whales could have evolved from terrestrial, hoofed ungulates (see Edwords, 1983).

The Eocene *Basilosaurus* has been recognized to be a primitive archaeocete whale since the 1830s. Its presence is a source of embarrassment to creationists, some of whom claim that it not only is no whale, but that it is a reptile, and a terrestrial one at that (e.g., D.T. Gish, as reported by Fezer, 1993). The recent discovery of vestigial limbs in this fossil form (Gingerich et al., 1990) provided further discomfiture, and has led some to deny that the limbs are vestigial (D.T. Gish; see Fezer, 1993), and others to challenge whether the limbs actually belonged to *Basilosaurus* (Johnson, 1991). Still, even if acknowledged by creationists as a whale, a significant gap exists between this genus and the terrestrial hoofed mammals.

One of the most dramatic fossil discoveries of this decade is of extinct whales of the genus *Ambulocetus*, from Pakistan, an area formerly covered by the Tethys Sea (Thewissen et al., 1994). Like *Basilosaurus*, *Ambulocetus* dates from early Eocene strata of about 50 million years ago, and its skeleton suggests that it was the size of a male sea lion (300kg). This ancestral whale not only exhibits robust forearms, but hindlimbs with the standard complement of mammalian skeletal elements. The hind feet are very large, and each toe terminates in a convex hoof like that of mesonychians. *Ambulocetus* also retains the primitive, mesonychian tail structure. Thewissen et al. (1994) concluded that the animal locomoted in water by vertical undulation of the spine, as in modern whales, coupled with hind limb propulsion, as in the mesonychians. In addition, *Ambulocetus* evidently could also walk on land. By virtue of its skeletal structure, stratigraphic age, and mode of locomotion, *Ambulocetus* represents a critical intermediate between the hoofed mesonychians of the early Cenozoic and the archaeocete whales (Berta, 1994).

Other important archaeocete fossils have also come to light. Well-developed hindlimbs have now been described in Eocene whales of the genera *Indocetus* and *Rodhocetus* (Gingerich et al., 1994). In *Rodhocetus* (as in *Ambulocetus*), the skeletal structure is of an animal that could locomote in water as well as support itself on land (Gingerich et al., 1994). Furthermore, the hindlimbs are somewhat reduced, but not nearly so small as in the aquatic *Basilosaurus*. Thus, an evolutionary reduction in hindlimb length was occurring in the Eocene, in concert with the invasion of marine habitat.

In sum, recent fossil discoveries, along with molecular studies and cladistic analyses, have provided powerful confirmation that whales are closely related to ungulates. Paleontology also has revealed details of how the transition from terrestrial mesonychians to aquatic life was accomplished. Perhaps creationists will have to find some other evolutionary transformation to ridicule.

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Caecilian Origins

One of the three major lineages of living amphibians (i.e., "lissamphibians"), is a group of elongated, limbless forms commonly known as *caecilians* or *apodans* (literally, "without feet"). Caecilians are located in the damp tropics. Because they lack limbs, one might be mistaken for a snake or annelid worm. However, caecilians have a spinal column and ribs, a head and brain of the vertebrate type, and such "amphibian" features as a glandular skin and a reliance on water for reproduction. Most caecilians are highly specialized for burrowing, and have small eyes, and strong skulls with which they push through the soil. About 162 species are known (Duellman and Trueb, 1986).

Because caecilians share several unique, specialized features both with salamanders and with anurans (frogs and toads), they often are thought to share a common terrestrial origin with these amphibian groups (Duellman and Trueb, 1986). Some researchers consider that caecilians originated from extinct microsaurs of the Paleozoic, which had limbs, and often, elongated bodies (Carroll, 1988). Whatever their exact affinities, caecilians almost certainly originated from a terrestrial ancestor with fully-developed eyes, forelimbs, and hindlimbs. Nevertheless, among living caecilians, the eyes are reduced and no vestige of limbs or skeletal limb girdles remains. Furthermore, until recently, caecilian fossils were confined to some isolated vertebrae of the late Mesozoic and early Cenozoic (Carroll, 1988). Thus, the gap between the distant, terrestrial, limbed amphibians and the extant, limbless caecilians has been considerable, and entirely of the type that creationists use to claim that major animal groups did not arise through evolution.

The recent description of an extensive series of caecilian fossils offers strong confirmation for common views of caecilian evolution. The discovery comprises 38 specimens of a new species, *Eocaecilia micropodia*, which dates to the early Jurassic (Jenkins and Walsh, 1993). Like modern caecilians, this fossil animal was elongate, with a compact, robust skull; remarkably, however, it had large eye openings (orbits) and both forelimbs and hindlimbs. The limb skeletal components are typical of terrestrial vertebrates; the forelimb contains a humerus, radius, ulna, and the hindlimb, a femur, tibia, and fibula. Nevertheless, the limbs are somewhat shorter relative to the vertebrae than those of most extant salamanders (Jenkins and Walsh, 1993). Thus, some degree of limb reduction apparently was underway in caecilians by the Jurassic.

The Mesozoic *Eocaecilia* offers an ideal intermediate between the limbed amphibians of the Paleozoic and the extant caecilians, with regard to structure of the limbs, the skull, and the axial skeleton. *Eocaecilia* also provides valuable information about the affinities of caecilians, because of its shared similarities with microsaurs, as well as with salamanders and anurans (Jenkins and Walsh, 1993). Although caecilians comprise one of three major lissamphibian groups, the fossil find has received little public attention.

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However, the discovery is arguably one of the most important fossil finds of the decade, and further discredits the creationist position that major animal groups lack a fossil history.

Avian Evolution

The early evolution of birds has received more attention from creationists than has any other evolutionary transformation. A major reason for this attention may be that *Archaeopteryx* represents an ideal intermediate between birds and their presumed ancestors, small theropod dinosaurs known as coelurosaurs.

Archaeopteryx is known from six Jurassic specimens from southern Germany, three of which have become known to science only in the past 25 years (Wellnhofer, 1990). Not until the 1980s were techniques of cladistics and analytical morphology applied to these fossils. Thus, much of what we know is based on recent study.

Archaeopteryx is usually classified as a bird because it exhibits such derived, avian features as feathers and wings. However, it retains a host of theropod features, including teeth, forelimb claws, unfused forelimb digits, a furculum (wishbone), abdominal ribs, bipedalism, an intratarsal joint, four hindlimb digits, and a long bony tail (Carroll, 1988). Except for the furculum and features of the hind limb, most of these theropod features do not occur in modern birds. *Archaeopteryx* also lacks an enlarged "keel" on the sternum, which in modern flying birds, serves for attachment of the flight muscles. The fact that *Archaeopteryx* is a mosaic of reptilian and avian features does not, of course, imply that it was the direct ancestor to all living birds (Wellnhofer, 1990); it may well have been a cousin to such an ancestor. Nevertheless, most of its features are what one would expect a distant avian ancestor to exhibit (Carroll, 1988).

So convincing is *Archaeopteryx* as a transitional morphotype that some anti-evolutionary works concede the point, and focus instead on other issues (Johnson, 1991). Most, however, treat the issue as too serious and too well-publicized to ignore. Thus, as discussed above, some creationists argue that *Archaeopteryx* is not equally transitional in all of its features—a true statement that reveals a fundamental lack of understanding of the pattern of evolutionary change. Another creationist criticism discussed is that this fossil form is a "bird" by definition, and that a gap therefore must exist between it and its reptilian ancestors (Bliss et al., 1990; Morris, 1974a). From a biological standpoint, this argument is a vacuous, semantic quibble (Ruse, 1982).

More to the point are claims that a major structural gap exists between *Archaeopteryx* and its theropod ancestors (Gish, 1979). The large number of theropod features retained by *Archaeopteryx* refutes this argument. In fact, so similar is the morphology of this proto-avian form to that of a bipedal dinosaur, that one museum specimen was misclassified as a theropod for

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several years, until close examination revealed the imprint of feathers (Wellnhofer, 1990). The creationist claim that *Archaeopteryx* is too "avian" to be an intermediate holds a certain irony; many biologists have concluded that it was so similar to the theropods from which it was derived, that it was a bipedal runner with limited flying ability (Vasquez, 1992; Wellnhofer, 1990).

Until recently, the fossil record exhibited a large discontinuity between the Jurassic *Archaeopteryx* and the highly specialized birds of the late Cretaceous. The latter included two groups of toothed forms: hesperornithiformes, which were flightless diving birds, and ichthyornithiformes, proficient flyers that resembled living gulls and terns (Carroll, 1988). Oddly, creationist writings do not focus on this fossil gap, perhaps under the misconception that *Archaeopteryx* was much like modern birds.

In any case, this discontinuity now has been filled with the discovery of an astonishing array of Mesozoic forms. Many are enantiornithines, a highly successful Jurassic and Cretaceous group with a worldwide distribution (Feduccia, 1995). These bird species varied from the size of a sparrow to that of a turkey vulture; most were arboreal but some were aquatic, and others were long-legged shorebirds (Chiappe, 1995). Enantiornithines retained many primitive features of *Archaeopteryx* (including clawed wings and teeth), but were fully able to fly, with the specialized flight apparatus and shortened tail of modern birds (Feduccia, 1995). Bone histology suggests that these birds were not fully endothermic ("warm-blooded") as are modern birds (Chiappe, 1995). Another form, *Mononykus*, was a bizarre, primitive, flightless bird with very short, but stout and strong forelimbs, each of which terminated in a single finger endowed with a hooked claw (Norell et al., 1993). For what function these strange limbs were adapted is a mystery. Equally intriguing is the fact that this flightless bird had a sternal keel. Cladistic analysis indicates that this bird and its allies originated after *Archaeopteryx* but before the enantiornithines (Chiappe, 1995). Yet another type of bird is represented by *Patagopteryx*, a stout flightless animal with vestigial wings, from late Cretaceous strata. Cladistically, this bird appears to have diverged after the enantiornithines but before the more advanced hesperornithiforms and ichthyornithiforms (Chiappe, 1995).

In sum, paleontological studies have provided a wealth of information about the origins and early evolution of birds. The purported gap between *Archaeopteryx* and its dinosaurian ancestors, so often cited by creationists, is now known to be minimal. The discontinuity between *Archaeopteryx* and modern birds, largely overlooked by creationists, has been eliminated through the discovery of an extraordinary diversity of Mesozoic species, a diversity that was unsuspected twenty years ago.

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Other Groups

Many other recent discoveries bearing on the origins of animal groups can be cited. One example is a newly-described hominid, represented by 18 fossils uncovered in Ethiopia. First named as *Australopithecus ramidus*, this form may warrant recognition as a new genus (White et al., 1994, 1995; Wood, 1994). To put this important find in context, over the past 25 years, paleontology has revealed the history of the hominid lineages in astonishing detail. In addition, molecular studies have suggested that hominids diverged from the common ancestor that they share with the other great apes only about 4 to 6 million years ago. The temporal and structural gap between *A. afarensis* (to which the "Lucy" skeleton belongs) and this common ancestor must be a small one. The new discovery of *A. ramidus* fills this gap. At 4.4 million years old, this species extends the hominid line backwards by half a million years, into the time range within which humans and apes probably diverged. In terms of its dentition, this species is even more apelike than other *Australopithecus*, and suggests a particularly close relationship with chimpanzees (Wood, 1994).

Another case is offered by fossils bearing on the early evolution of turtles (chelonians). For many years, a significant gap existed between the primitive genus *Proganochelys* of the late Triassic (200 million years ago), and turtles with modern features, which appeared 140 million years ago in the Jurassic. The discovery of an early Jurassic turtle (*Kayentachelys*) has extended the record of morphologically-modern turtles back to 185 million years (Gaffney et al., 1987). Other discoveries and analyses have revealed many details about the Triassic radiation of early turtles, and have shown that *Proganochelys* may actually be the closest non-chelonian relative to the turtles (Rougier et al., 1995). If these interpretations are correct, the largest discontinuities in the fossil record for turtles have now been filled.

Still another example is offered by the description of the oldest known lizard of the family Iguanidae (sensu Frost and Etheridge, 1989). Although this lizard family is diverse and has a wide distribution in the Americas, until recently, its oldest unequivocal fossil dated back no further than the late Pliocene. The recent description of a new fossil (genus *Armandisaurus*) has extended the paleontological record for this lizard family back into the Miocene (Norell and deQueiroz, 1991). Cladistic analysis has shown that this species is primitive morphologically, and lacks derived features of most other iguanids, just as one would expect for an early member of the family.

Conclusion

For reasons discussed above, transitional morphotypes tend to be less well represented in the species record than the major groups that they link. Nevertheless, evolutionarily intermediate forms abound. Examples described

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herein represent some of many that can be cited from recent vertebrate research. From older literature, Cuffey (1984) chronicles numerous other cases of species that show intergradations between higher taxa, including plants (angiosperms and gymnosperms), vertebrates (reptiles, therapsids, mammals, and hominids), and invertebrates (gastropods, brachiopods, crustaceans, crinoids, and ammonoids). He also documents innumerable transitional species that show intergradations within genera, and many evolutionary transformations represented as chronologically successive fossils. Other examples are found throughout the biological literature, in major reviews (e.g., Carroll, 1988), and in textbooks of zoology, botany, and paleontology.

Creationists have placed themselves in a tenuous position by basing their arguments on negative evidence, i.e., the purported absence of evolutionarily intermediate morphotypes. Perhaps unintentionally, or through an overconfidence borne of ideology, they have framed their views in a way that allows them to be refuted. Falsifiability is a minimal criterion for any endeavor that aspires to intellectual respectability. However, if creationists have such aspirations, they seem to find them to be incompatible with their political and social agendas. Even the most charitable reading would find it hard to explain the self-serving distortion, deception, and obfuscation in creationist writings, as have been so abundantly documented in *Creation/Evolution*, and in books by biologists, philosophers, and anthropologists (e.g., Eldredge, 1982; Futuyma, 1982; Kitcher, 1982; Ruse, 1982; Montagu, 1984).

The creationist challenge to biology, to find even "five or six of the transitional forms scattered through time . . . " (Gish 1979, p. 49) has been met and exceeded. Thus, creationism has been refuted according to criteria of its own choosing. Unfortunately, if recent history is any indication, creationism seems likely to continue to pursue its sociopolitical agenda with little concern for mere empirical evidence.

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Reviews

The Evolution Controversy in America. by George E. Webb, Lexington: University Press of Kentucky 1994, 297 pp. $34.95 hardcover

Review Essay by Stanley L. Weinberg Ottumwa, IA, Founder of the Committees of Correspondence

George E. Webb is a history professor at Tennessee Technological University and lecturer in a science history course. On one occasion a student in Professor Webb's science class confronted him both on the campus and at his home. The student was clearly a devout religious fundamentalist who felt aggrieved. He was committed to a literal and inerrant Bible and a young Earth; he believed in creationism while rejecting evolution; he saw science as based on visible facts in accord with Francis Bacon's medieval philosophy, while he rejected circumstantial evidence, hypotheses, theories, and similar unacceptable (to the student) modern inductive science.

The persistent (though not quite abusive) student informed Webb that he (Professor Webb) was an atheist and not a Christian; therefore the lecturer had no right to criticize the student's beliefs. Webb was taken aback by this unusual challenge. In return Webb asked the student if he (the student) had the right to judge him (the professor). The answer was, "Of course I do, Christ gave me that right."

At times Webb had met other creationist students who also challenged his lectures. When he regained his composure he began to wonder what caused such contentious and vituperative attitudes toward evolution and modern science. Webb attributes these intransigent challenges to the poor education of the semi-literate fraction of the American public, and especially to poor science teaching. As he states in his preface, there is a "significant continuity" between the period of Charles Darwin's early opponents on the one hand, and the "anti-evolutionists of the 1920s" on the other. The continuity led Webb to undertake this book.

Webb spent some ten years writing his book. As he worked, he suffered progressive kidney failure, which in 1991 led to a renal transplant. (He has now regained his health and has returned to teaching.) This reviewer must admire the author for producing such an impressive document under great physical and mental stress.

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Content of the Book

The Evolution Controversy in America tells a continuous story with three main threads. One is Charles Darwin's *Origin of Species* with some supporting biological data. Another thread involves theological developments, including fundamentalism with roots in the early 18th century. The third stream is "scientific creationism" and the creation/evolution (C/E) controversy that has been raging in the U.S. through the 1980s and early 1990s.

A Prologue, ten Chapters, and an Epilogue cover these three issues. The ten pages of Epilogue bring the controversy up to date—that is, from the late 1980s through 1994. The latter date is the year of publication. Supplements in the book include a twenty-page Note Section with 568 notes, many of them with multiple references; and a smaller, seven-page Index Section.

The text of the book is simple, readable, literate, and interesting. Readers may find a short survey of the dozen textual Chapters and Sections helpful. The Prologue briefly introduces other more modern scholars; also Darwin and Darwinism. The Prologue then makes a smooth transition to the early Chapters. Here Darwin's reception in America is discussed, stressing Asa Gray and Agassiz, paleontologists Cope and Marsh, and various clergymen, both pro- and anti-evolution.

The Early Chapters

A few noteworthy theistic evolutionists featured in the first three Chapters include James McCosh, President of Princeton, Brooklyn's Presbyterian minister Henry Ward Beecher, Herbert Spencer, and Yale sociologist William Graham Sumner—the latter two were popular social Darwinists—T.H. Morgan and the staff in his genetics lab at Columbia University, August Weismann, and Maynard Shapley with his popular journal *Science League of America*.

Prominent anti-evolutionists who also appear in these Chapters—along with minor personalities—include Dwight L. Moody, George McCready Price, Billy Sunday, William Jennings Bryan, and Minnesota's William Bell Riley, founder of the World's Christian Fundamentals Association. These active fundamentalist leaders helped initiate anti-evolution bills in various states.

Chapter Four focuses on the Scopes "Monkey Trial" and its consequences. One consequence was rejection of anti-evolution bills in many states; yet these bills survived in Tennessee, Mississippi, and Arkansas. At Vanderbilt University in Tennessee, Prof. Alexander Winchell was discharged from his professorship because he held that human beings lived before Adam and Eve—a heresy that believers in an inerrant Bible would not tolerate. Yet various other states rejected anti-evolution bills. As one example, the Delaware legislature amusedly referred its creationist bill to the Committee on Fish, Game and Oysters, where it quietly died.

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Chapters Five and Six continue to pursue the consequences of the Scopes *Monkey Trial* through the decade of the 1960s. The creation/evolution controversy expanded in several directions. There were disputes over which choice—evolution or creationism—should be adopted for textbooks and school curricula. Evangelical churches flourished. Jerry Falwell, the Gabler couple (pp. 141, 201) and other prominent evangelicals received appropriate attention. So-called "Christian schools" increased; they are often called "fundamentalist schools," since fundamentalists sometimes attribute true Christian faith only to themselves.

On the pro-evolution side during the 1960s the discovery of the structure and function of DNA (Also called the "double helix"), the "modern synthesis" as a dramatic restructuring of biology; and the wide use of the evolution-oriented BSCS books, were important contributions to science, to evolution, and to education. Fisher, Haldane, Simpson, Dobzhansky, Watson and Crick, and Muller are especially prominent contributors. Webb also describes the 1966 Epperson case in Arkansas and its contribution to the decline of the various anti-evolutionist statutes (pp. 143-145).

The Later Chapters

Reaching as far back as the 1930s and 1940s for resources bearing on the C/E controversy, Chapters Seven through Ten cover the decades of the 1970s and 1980s. Webb defines these decades as the period of "creation science." He stresses the efforts of the evangelicals to establish a "creation science model" as equal in authority to the "evolution science model." Organizations and publications were set up to validate this posture. Resulting lawsuits attracted national attention.

The first and most successful publication that promoted the growing "scientific creation" movement was *The Genesis Flood.* This best seller advocated an inerrant Bible, a young earth, Noah's Flood, and a "creation science" model. The authors were Henry M. Morris, a fundamentalist and hydraulic engineer, and the theologian John C. Whitcomb. Webb describes several other important creationist books.

The newly formed "creation science" organizations generally flourished. Henry Morris had a hand in several of them—Institute for Creation Research (ICR), Creation Research Society, Creation Science Research Center, American Scientific Affiliation. There were others, but ICR was—and still is—far and away the most influential. Morris and his associate Duane Gish tirelessly traveled the U.S. and abroad in their missionary work supporting creationism. They spoke before hundreds and thousands of devotees in churches and on university campuses. They debated—usually successfully—enthusiastic but less eloquent pro-evolution speakers.

Webb's four final chapters cover specific creationist strategies as well as the broad scope of the controversy. Besides focusing directly on evolution,

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the creationists also attacked ancillary targets such as "secular humanism," and "equal time" or "balanced treatment" for the "two models." Various lawsuits resulted. Especially in Texas, California, Iowa, Colorado, Tennessee, West Virginia, and Arkansas, along with some other targets, battles continued over curricula, textbooks, and creation-or-evolution laws.

The Evolution Controversy

The scientific world was not totally oblivious of creationist activities. Organizations such as AAAS and the National Academy of Sciences published materials in behalf of evolution and appeared before courts, legislatures, and school boards. A few of the leaders in these efforts were Francisco Ayala, Michael Ruse, William V. Mayer, Stephen Jay Gould, William M. Thwaites, and Frank Awbrey. These and other scientists were sometimes successful in giving the creationists a hard time. But the latter side was never wiped out, and indeed it is very much alive today.

The ten-page Epilogue brings Webb's book up to date—that is, up to 1994. Webb discusses fiery conflicts in California and Texas—perennial battlegrounds—and in a few other states as well. There were also open disputes involving particular publications. *Scientific American* is a leading popular science journal. Its editors intended to hire an able science writer named Forrest M. Mims, but they withdrew the offer when it appeared that Mims was a committed creationist. Intense arguments arose over the propriety of Mims' treatment.

Another dispute focused on *Darwin on Trial* by Phillip Johnson, a University of California Law Professor. The volume was anti-evolutionary, it sold well, and creationists and their followers lauded it to the skies. Evolutionists in general rejected the book. They called Johnson an incompetent with respect to science and evolution, and basically a creationist. Indeed Johnson supports "intelligent design," which critics see as a form of creationism. Several other publications that deal with intelligent design have also appeared.

The Epilogue serves as a sort of coda that brings *Controversy* to a smooth close. The entire book gives the impression of a dissertation laboriously put together in a library and not quite complete. The extensive documentation, and the detailed data that appear all through the book clearly show Webb's reliance on research. There is certainly nothing wrong with this. Yet however well written the book is (and indeed it is), its literary and bookish tone is remote from the Sturm und Drang one might expect in a history focused on a current controversy.

Aside from the literary tone of the book, the author gives little indication of any personal involvement in the many exciting areas he touches upon. Webb's story could have been more rounded had he introduced greater human interest, and made personal contact with more of the significant characters. Many are still available and Webb could at least have interviewed

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some of them. The important dramas embedded in *The Evolution Controversy in America* rarely show themselves, and there is some loss of completeness and accuracy. The lapses in Webb's style turn a well written book into a somewhat pedantic one. Yet the several last pages of the Epilogue give a less pedantic and more personable impression.

Evaluating the Text

In view of the many good qualities in Webb's work, I regret the lapses just described. I base the comments on my involvement in the C/E conflict over many years, and cite some examples from my own early experiences.

Webb describes Darwin's 1835 visit to the Galapagos (p. 3), his careful examination [*sic*] of the islands' finches, and his contemplation of the possibility of evolution. This is doubtful. Darwin's study of finches was quite careless—for Darwin. Captain FitzRoy gave Darwin his own more carefully studied collection, and all the birds were shipped together to London. Back home in England and in London in 1836, ornithologist John Gould accurately described to Darwin the variety of species and the relationships among the birds. Also in London in 1837 (but not in the Galapagos), Darwin started his first notebook listing evidence for evolution. Webb is correct about Darwin in London, though the evaluation of his work in the Galapagos is incorrect.

Another intriguing story deals with two early U.S. paleontologists, Edward Drinker Cope (pp. 23-28, 38, 44-46) and Othneil C. Marsh (pp. 15, 42-43). They began as good friends and students of pioneer paleontologist James Hall. Webb describes Cope and Marsh as primarily advocates of neo-Lamarckism—a unique branch of evolution theory. (Webb gives perhaps too much attention to neo-Lamarckism.) Cope's and Marsh's fabulous achievements over many years involved collecting mammalian and other fossils in the American West—horses, dinosaurs, giant toothed birds, and so on. The two scientists became such intense competitors that they had their respective digging teams raid each other. Later Cope taught at the University of Pennsylvania, and eventually gave his vast fossil collection to the American Museum of Natural History. Marsh had a similar role at Yale. Many of Cope's fossils are still stored in the Museum cellar and some have not yet been studied or exhibited. I have taken my students to visit the fossil stores, to their delight.

California Affairs

The C/E controversy has racked California in many ways—through framing of curricula, the purchase of textbooks, the right of teachers to teach creationism, the handling of "creation science" by ICR, and the like. Bill Honig, elected in 1982 as State superintendent of Education, battled for years, with considerable success, in defense of evolution. However, he became involved in ICR's right to grant graduate degrees in "creation science." ICR

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initiated two lawsuits and won both, gaining the right to teach creationism as a scholarly discipline! Besides losing the cases, Honig also lost his control over institutions such as ICR, and most of his authority as Superintendent.

Thus far Webb tells the Honig story quite well. But there is more to tell. Creationist politicians were not satisfied just to beat Honig, they wanted to destroy him. Honig was charged with "felony conflict of interest," based on an educational program that his wife conducted. Honig was convicted; he has lost his job, his career, and his civil rights; he faces a heavy fine; and his case is now on appeal. The most shocking aspect of this case is that Bill Honig, for years a loyal friend of evolution and science, has been virtually ignored by the scientific community beyond NCSE. However, Eugenie Scott has publicly paid him honor at a 1994 NCSE annual celebration. When the Appellate Court hands down its decision I hope to publish this whole sad story.

Iowa and the Committees of Correspondence

The account of the C/E controversy in Iowa is grossly incorrect. Webb states that the Iowa legislature dealt with one anti-evolution bill (pp. 208-209). Actually there were nine bills between 1977 and 1982. The leading creationist in the state was Harry Bert Wagoner, a non-scientist telephone company employee. He recruited supporters, and harried politicians, government officials, staff of the Department of Public Instruction (DPI), local school officials, teachers, and others. Because Dr. Benton, Department of Public Instruction Superintendent, and his science consultant Jack A. Gerlovich, understood that I was familiar with the C/E controversy, they asked me to do something about the harassment they were undergoing. I agreed, and arranged contacts between DPI and the Iowa Academy of Science (IAS).

So I set up two units: One was a "Committee of Correspondence" (C/C), an autonomous, independent, politically-oriented group evocative of the similarly-named political agencies during the American Revolution period. The other was an "IAS Panel on Controversial Issues." These two groups worked together and cooperated with many other bodies: mainline churches, the Des Moines Catholic diocese, colleges and universities, educators and nurses associations, scientists, other professionals, Governor Robert Ray, the general public, labor leaders, and so on. Together we defeated all nine creationist bills. We went on to counter creationist efforts throughout the state—in courts, the press, the legislature, government, schools at all levels, some religious bodies, and a good part of the general public. Our organization operated successfully mainly because of its political orientation. Having grown up amid the intricacies of New York City politics, I was well equipped to deal later on with grassroots politics in Iowa.

The evolution defense activities in Iowa received considerable attention in the national press. Soon we began to hear from other states—New York, Kentucky, Minnesota, Georgia, and California were the first—where groups

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similar to the Iowa C/C were already active. These Committees affiliated with the Iowa C/C, and together we created an informal network. We also heard from individuals in states where there were no C/C's yet, but who wanted to organized their own Committees and join the network. We welcomed applicants into the network, now called the "Committees of Correspondence" movement. We told each group that they could use the "C/C" name or any other name they wished; and that we expected each C/C to remain autonomous and independent but cooperative with other C/C's. The network would exercise no authority over the C/C's, but we would help any that needed us. We especially showed how local politics could be valuable in supporting evolution.

The Committees of Correspondence

The C/C movement was astonishingly successful. Within three years there were fifty C/C's in fifty states. In his book *History of Modern Creationism* (1984), Henry Morris evaluates his pro-evolution opponents as below. His account is roughly but not totally accurate—for example, I am not a "doctor."

> Another organizational step was taken by Dr. Stan Weinberg. . . . He initiated what are now called "Committees of Correspondence," local groups of committed evolutionists who will do battle for evolution whenever creationism appears in any kind of organized, local effort. By 1982 many of these were well organized and quite active, and we have been encountering their activities, both directly and indirectly, with increasing frequency. . . .

I did indeed initially organize the C/C movement. At first I was not formally elected to any office, but I led the organization and kept in touch with the "Liaisons—heads of the various C/C's. In time I set up the "National Center for Science Education" (NCSE) as President. NCSE served as an umbrella to support the C/C's. I edited and printed a bimonthly NCSE newsletter and distributed it to C/C's nationwide. The newsletter is in its fifteenth volume, and is currently titled *NCSE Reports*. (I am not now involved with NCSE or its newsletter.)

The reader will understand that managing this nationwide organization single-handed was quite a burden. I worked from a back bedroom in a small Iowa town, with no employees or staff. Funds for office expenses, phone, travel, printing, etc. came mostly from my pocket. The C/C's absorbed my other obligations and interests, and my family and private life. Also my health was fragile. So after three years I resigned my leadership, but remained on the NCSE Board another three years. Before retiring finally, I raised from foundations a quarter of a million dollars to place NCSE and the C/C's on a solid base.

Webb mentions Eugenie Scott several times (pp. 210, 214, 242, 257). Scott is an anthropologist. After NCSE obtained grant-funding, a search

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committee was formed and hired her as Executive Director. Scott is a person of charm, energy, and ability. She writes and speaks well and is active in both areas. She is warm, firm, and authoritative. Scott has made the NCSE Executive office a center for information and help for communities that have problems with creationists. This operation functions on the national level, Scott has set it up superbly, and she is known nationwide for her work.

The success of the NCSE center has another side. In their "glory days" the C/C's were successful as political units. In the current administration they have become branches of NCSE and are often so described. By 1986 Scott was well aware that the Committees of Correspondence were either dead, fading, or existent in name only. Board members racked their brains to find a way the bring the C/C's back to life, but without success. One Board member, currently editor of this journal, remarked: "You cannot manage a grassroots operation from the top down." So the Board resolved to stick with the national level NCSE operation that was proving to be so successful.

Grassroots Politics

Scott and NCSE have found central office management valuable for national level operations but it's no substitute for grassroots operations. Every successful politician and every competent journalist is aware of the aphorism, "American politics is local politics." Scientists in general are unaware of, or uninterested in, such local grassroots politics.

In 1993, depending on local political action, creationists took over school boards in Vista and several other towns in the San Diego area. NCSE folks assisted counter groups, who in 1994 won back most of the captured school boards. Also, at a 1994 AAAS meeting in San Francisco, Scott appealed to the audience to get involved in local politics as vigorously as the creationists do. Responses to such appeals seem negative nationwide—except in a few places such as the Vista, California area. Thus NCSE thrives while the C/C's deteriorate.

Webb's Epilogue undertakes to wrap up his book by surveying the evolution controversy from the late 1980s. He recognizes that creationists could no longer depend on lawsuits to control education and "creation science." The creationists recognized this also, and they were shrewd enough to realize that politics is now the significant factor, and local politics is the arena. This sounds like a C/C network, which indeed it mimics. Three pioneer grassroots political networks were "Citizens for Excellence in Education" (CEE) headed by Robert L. Simonds; the "Christian Coalition" led by Pat Robertson and now Ralph Reed; and Phyllis Schlafly's "Eagle Forum." These leaders, especially Ralph Reed, arranged one- or two-day seminars for as many as two hundred members of local units at a time. The members were well trained in the tactics of local politics.

There were also a dozen or so smaller but similar Christian networks. Policies they all favor include creationism, "family values," book censorship,

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prayer in school, home schooling, capital punishment, Christian Academies, etc. Unacceptable policies include sex education other than abstinence, evolution, pornography, secular humanism, socialism, abortion, ERA, and many others.

After the Religious Right political candidates win their seats and control a school board, they expose their secretive objectives and make them operative. (Ralph Reed openly refers to them as "stealth candidates.") The U.S. has about 16,000 local school boards. During the early 1990s the Christian Right networks had units in an estimated fifteen hundred of these boards, along with such other bases as city councils and legislative bodies. Their school board contestants won about 40 per cent of the seats they campaigned for.

In the 1992 national election the Religious Right set up statewide Republican "Far Right" political networks or caucuses. Ralph Reed planned the campaign in the style of the "Stealth" local units. The purpose was not to control school boards or city councils, but to control Republican (GOP) state parties. To the surprise of moderate and mainline Republicans, the Stealth caucuses won six states immediately—Iowa, Washington, Oregon, Virginia, Texas, and South Carolina—and they have since won control of additional states' GOP leadership. One astonished Grand Iowa Republican Lady, Mary Louise Smith, marveled: "It isn't a political party any more. It's almost a religious organization." The Far Right Republican politicians were in Seventh Heaven. The same political tactics that had worked for them earlier worked for them again in the 1994 national election. They swept both Houses of Congress, elected nine governors in ten of the largest states, took control of numerous legislatures, and won various other prizes as well.

Conclusion

In the last pages of the Epilogue, Webb describes very well the skillful grassroots political tactics of the Religious Right. Battered pro-evolutionists would do well to learn grassroots politics from Webb's comments, from repeated comments in this review, and from numerous discussions of political developments in the media. Webb also deserves substantial credit for his observing, researching, and reporting the expansion of the evolution controversy in the U.S.; for his understanding the development of the Religious Right; and most of all for his recognition of the probable future continuance of these aspects of American culture.

Note

Articles by Stan Weinberg and Jack Gerlovich are mentioned in Notes to Chapter 9. Neither author is mentioned in the Index or Chapter text. None of the materials available in these sources—some of which are referenced in this review—seems to have been used in *Evolution Controversy in America*. C/E

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Comments

More on Debates

Peter E. Kane
Churchville, NY

Eugenie Scott's cautions (14(2):22ff) about debating creationists are well taken. However, the view that such confrontations should generally be avoided seems to rest on the too-frequent failure of scientists to understand and make use of the special qualities of the debate format. Armed with such understanding, debates offer scientists an opportunity that should not be automatically rejected. As a strictly amateur biologist whose professional work is in rhetorical criticism and theory and for a while a debate team coach, let me offer a few suggestions:

1. The format should take into consideration the capacities of the audience by limiting the total presentation time to about an hour (perhaps followed by a question period) [rather than the 2-3+ hours creationist debaters typically favor]. This would allow opening statements of 15 minutes each followed by 10 minute rebuttals and 5 minute summaries—a format followed by organized, competitive debating.
2. No matter how the debate topic is stated, the creationist is proposing a change from the present system . . . so the burden of proof must be placed squarely on the creationist to make a positive case rather than simply to attack evolution. The scientist's first presentation should make this clear to the audience. List unanswered questions such as: What is the creationist model? What are the mechanisms of creationism? How does their model advance our understanding of the natural world? Tell the audience to demand answers to these fundamental questions. (If they can be posted on newsprint or a chalkboard before the audience, all the better.)
3. Establish that the creationists have failed to discharge basic debate obligations and turn to what they have actually said. It is likely that the presentation was some version of the "Gish Gallop," including standard topics such as the absence of transitional forms, or the second law of thermodynamics bit.
   The evolutionist needs to make clear that these arguments have been refuted time and again by experts, so why does the creationist trot out these completely discredited arguments? . . . A more aggressive de-

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bater might cite *Exodus* 20:16 ("Thou shalt not bear false witness"). Challenge the audience to demand an explanation of why they have been lied to.

5. At this point the evolutionist can offer a brief exposition of the reasons that the concept of evolution is the fundamental organizing principle in virtually all the natural sciences.
6. In rebuttal and summary, press for answers to the questions that will likely be unanswered by the creationist. If answers are presented that invoke God or Scripture, the fact that these are religious rather than scientific answers should be pointed out.

This outline would seem to place the burden of proof on the creationist where it belongs. It places the scientist on the offensive. Scott is quite correct that the defensive posture used by scientists in most debates is a losing proposition. Even if the creationist is preaching to the choir, there may be some in the audience who take the questions raised to heart and begin to think seriously about the issues. If even just a handful of people begin to think, the scientist has had a worthwhile evening.

Ed: These are excellent pieces of advice. However, I would also like to summarize the advice of Fred Edwords, founding editor of this journal and a fine creationist-debater. As a non-scientist trained in debate, he noted that most scientists are not trained debaters. Furthermore, he noted that someone such as he is not seen as speaking with "the voice of science," so his performance is not easily capitalized upon by creationists—they are unable to say "Gish trounces Nobel Laureate!" Whether or not there is some kind of objective "trounce" is irrelevant to the true believers in the audience who view debates as a form of "witnessing" or bravely going up against the anti-Christian lions, not a true scientific debate. C/E

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Correspondence

• *I am sorry that Jonathan Marks (14(2):40-41) was unprepared to understand* ***The Bell Curve****. I suspect that he fell victim of the usual reviewer's trap of reading the first and last pages of each chapter and then writing the review. Clearly he was operating from a "politically correct" frame of mind.*

As a geneticist, student of evolution and the genetic basis of behavior, I have kept peripherally aware of the work for about 45 years. The evidence and many of the conclusions of [the book] have been available to serious students for most of that [45 years]. I have not discovered convincing refutation of the ever-increasing genetic evidence. Herrnstein and Murray assemble and present the ever-improving population data. The evidence appears to be independent of race, but even if it were not, should we ignore it?

As with the evidence for evolution, it gets better with time. The more evidence accumulates, the easier it is to understand the old questions and ask new ones. Professor Marks, for whatever reasons, misses the whole point of the book: given the evidence for the hereditary basis of intelligence, it is poor public policy to waste resources attempting to educate people for things they cannot achieve, [such as the congenitally deaf being trained to sing opera.]

The book is not "racist," it is realist. It makes the strongest argument I have seen for good primary education and testing accomplishment as the basis of further education. This is a recipe for advancing individual achievement for all who will try. If Marks sees this as racism, that is his disability.

The book is elitist in the realistic sense that it recognizes human differences. This may be unpleasant to some of us, but it is not racist. I would urge all who care about the issues, and the future of our country, to study ***The Bell Curve*** *carefully from cover to cover before drawing invidious conclusions.*

Jack Bennett
Biology Professor Emeritus
Northern Illinois University, Dekalb, IL

Ed: This is one of many responses to a recent book review of ***The Bell Curve****; As most readers have probably noticed, critiques of this book's conclusions are not limited to Marks' review, nor is Bennett alone in defending the book. Many scholars such as geneticist Richard Lewontin and Stephen Jay Gould have criticized it in technical detail, for example, and the book's numerous supporters include creationism-debater Vincent Sarich, (cf,* ***The Skeptic*** *3(3): 84-93, 1995).*

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Submissions of manuscripts are welcome from anyone concerned with the issues that *Creation/Evolution* addresses, regardless of the author's formal academic background or profession, as long as these rules are followed:

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   Zubrow, Ezra 1985. *Archaeoastronomy*. Orlando, FL: Academic Press.

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